CLAIMS

What is claimed is:

1. In a plasma processing system, a method of determining the temperature of a substrate, comprising:

positioning said substrate on a substrate support structure, wherein said substrate support structure includes a chuck;

creating a temperature calibration curve for said substrate, said temperature calibration curve being created by measuring at least a first substrate temperature with an electromagnetic measuring device, and measuring a first chuck temperature with a physical measuring device during a first isothermal state;

employing a measurement from said electromagnetic measurement device and said temperature calibration curve to determine a temperature of said substrate during plasma processing.

2. The method of claim 1, further including the step of measuring a second substrate temperature with said electromagnetic measuring device, and measuring a second chuck temperature with said physical measuring device during a second isothermal state.

3. The method of claim 1, wherein said substrate is positioned between said plasma and said electromagnetic measuring device.

4 The method of claim 1, wherein said substrate support structure further comprises said physical temperature measuring device.

5. The method of claim 1, where said electromagnetic measuring device comprises a narrow-band pyrometer.

6. The method of claim 1, where said electromagnetic measuring device comprises a monochrometer.

7. The method of claim 1, where said electromagnetic measuring device comprises a grating.

8. The method of claim 1, where said electromagnetic measuring device comprises a band pass optical filter.

9. The method of claim 1, wherein said physical temperature measuring device is a thermocouple device.

10. The method of claim 1, wherein said substrate is a substrate.

11. The method of claim 1, wherein said substrate is a glass panel.

12. The method of claim 1, wherein said set of electromagnetic frequencies comprise the Infrared spectrum.

13. The method of claim 1, wherein said plasma processing system comprises chemical vapor deposition.

14. The method of claim 1, wherein said plasma processing system comprises plasma enhanced chemical vapor deposition.

15. The method of claim 1, wherein said plasma processing system comprises physical vapor deposition.

16. The method of claim 1, wherein said plasma processing gas includes Carbon.

17. The method of claim 1, wherein said plasma processing gas includes Hydrogen.

18. The method of claim 1, wherein said plasma processing gas includes Fluorine.

19. The method of claim 1, wherein said plasma processing gas includes Nitrogen.

20. The method of claim 1, wherein said plasma processing gas includes Oxygen.

21. The method of claim 1, wherein said plasma processing gas includes Argon.

22. The method of claim 1, wherein said plasma processing gas includes Xenon.

23. The method of claim 1, wherein said plasma processing gas includes Helium.

24. The method of claim 1, wherein said plasma processing gas includes Sulfur.

25. In a plasma processing system, an apparatus for determining the temperature of a substrate, comprising:

a means of positioning said substrate on a substrate support structure, wherein said substrate support structure includes a chuck;

a means of creating a temperature calibration curve for said substrate, said temperature calibration curve being created by measuring at least a first substrate temperature with an electromagnetic measuring device, and measuring a first chuck temperature with a physical measuring device during a first isothermal state;

a means of employing a measurement from said electromagnetic measurement device and said temperature calibration curve to determine a temperature of said substrate during plasma processing.

26. The apparatus of claim 25, further including a means of measuring a second substrate temperature with said electromagnetic measuring device, and measuring a second chuck temperature with said physical measuring device during a second isothermal state.

27. The apparatus of claim 25, wherein said substrate is positioned between said plasma and said electromagnetic measuring device.

28 The apparatus of claim 25, wherein said substrate support structure further comprises said physical temperature measuring device.

29. The apparatus of claim 25, where said electromagnetic measuring device comprises a narrow-band pyrometer.

30. The apparatus of claim 25, where said electromagnetic measuring device comprises a monochrometer.

31. The apparatus of claim 25, where said electromagnetic measuring device comprises a grating.

32. The apparatus of claim 25, where said electromagnetic measuring device comprises a band pass optical filter.

33. The apparatus of claim 25, wherein said physical temperature measuring device is a thermocouple device.

34. The apparatus of claim 25, wherein said substrate is a substrate.

35. The apparatus of claim 25, wherein said substrate is a glass panel.

36. The apparatus of claim 25, wherein said set of electromagnetic frequencies comprise the Infrared spectrum.

37. The apparatus of claim 25, wherein said plasma processing system comprises chemical vapor deposition.

38. The apparatus of claim 25, wherein said plasma processing system comprises plasma enhanced chemical vapor deposition.

39. The apparatus of claim 25, wherein said plasma processing system comprises physical vapor deposition.

40. The apparatus of claim 25, wherein said plasma processing gas includes Carbon.

41. The apparatus of claim 25, wherein said plasma processing gas includes Hydrogen.

42. The apparatus of claim 25, wherein said plasma processing gas includes Fluorine.

43. The apparatus of claim 25, wherein said plasma processing gas includes Nitrogen.

44. The apparatus of claim 25, wherein said plasma processing gas includes Oxygen.

45. The apparatus of claim 25, wherein said plasma processing gas includes Argon.

46. The apparatus of claim 25, wherein said plasma processing gas includes Xenon.

47. The apparatus of claim 25, wherein said plasma processing gas includes Helium.

48. The apparatus of claim 25, wherein said plasma processing gas includes Sulfur.

49. In a plasma processing system, a method of determining the temperature of a substrate during plasma processing, comprising:

creating a mathematical model relating temperature changes of said substrate to optical properties changes of said substrate, including

a) positioning said substrate on a substrate support structure of said plasma processing system, wherein said substrate support structure includes a chuck,

b) introducing a heat transfer gas between said substrate and said chuck,

c) allowing said substrate and said chuck to come to thermal equilibration, at which time said chuck temperature is measured using a contact measurement technique,

d) directing electromagnetic radiation of known spectral composition onto a surface of said substrate,

e) obtaining first electromagnetic energy measurement, said first electromagnetic energy measurement measuring first electromagnetic energy reflected from said surface of said substrate responsive to said directing,

f) employing said chuck temperature measured using said contact measurement technique and said first electromagnetic energy measurement to create said mathematical model; and

calculating said temperature of said substrate during said plasma processing, including

obtaining second electromagnetic energy measurement, said second electromagnetic energy measurement measuring second electromagnetic energy reflected from said surface of said substrate during said plasma processing, and

employing, using a digital computer, said chuck temperature measured using said contact measurement technique, said first electromagnetic energy measurement, said second electromagnetic energy measurement, and said mathematical model to perform said calculating said temperature of said substrate during said plasma processing.